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Davis, CA.

Data Report of Wind Tunnel Tests - Characterization of Beecomist Atomizing Three Tank Mixes of Dipel 6L

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DATA REPORT OF WIND TUNNEL TESTS-CHARACTERIZATION OF BEECOMIST ATOMIZING THREE TANK MIXES OF DIPEL 6L

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Preface

The work presented in this report was performed at the University of California, Davis (UCD), Department of Agricultural Engineering. The work was administered by USDA-Forest Service, Forest Pest Management Office, Davis, CA under purchase order arrangements.

The tests were requested by USDA Forest Service, Pacific Northwest Region, Forest Pest Management following field mixing and atomization problems with the tank mixes on the 1987 control project. Dipel 6L, a commercial product of *Bacillus thuringiensis* produced by Abbott Laboratory, was sent directly to UCD for the wind tunnel testing from the field project site. It was the same lot number used on the control project.

Wind tunnel testing of the three tank mixes of Dipel 6L did not identify any unusual formulating or atomization problems.

Introduction:

The tests were designed to measure the drop size spectra that would simulate an aerial application at an airspeed of 90 mph with a Beecomist nozzle and three different tank mix formulations containing Dipel 6L.

Equipment:

The tests were conducted in a wind tunnel with a test section 8 ft. long and 2 x 2 ft. cross section. A Particle Measurement System (PMS) probe, OAP-2D-GA1, with a PMS 11-C data acquisition system was used to measure the drop size spectra. The probe has a nominal class size of 33 μm. The system counts and classifies the drops into 62 size classes from 28 to 2062 μm.

All tests were conducted with a Beecomist 306A atomizer.

Procedures:

The Beecomist atomizer was operated at 28 VDC for all tests. A Strobotac was used to measure the cage RPM during each test. The flow rate was adjusted to 3.0 gal/min by selecting an appropriate flow regulator disc (Spraying Systems) and experimentally adjusting the pressure until the correct flow rate was obtained. The flow rate was determined by collecting the spray mixture in a bucket during a measured time interval.

The drop measurement procedures were similar to previous protocol developed for measurement of rotary atomizers. Briefly, the PMS probe was mounted with the laser beam located 5.25 inches above the bottom of the wind tunnel test section and 19 inches downstream from the rear of the rotary cage atomizer. The atomizer was positioned vertically at 7 radial positions representing equal areas of the spray pattern. Drop size frequency data from each segment was combined into a single composite distribution.

The tank formulations were mixed in a 30 gallon mix tank with a constant vigorous agitation from a paddle agitator. The mixing process started with the

required amount of water and then the desired amount of Dipel was slowly added while the agitation and pump by-pass was in operation.

Results:

Table I contains a summary of the drop size spectra for the tests with the three tank mixtures.

The spray mixtures were maintained under constant agitation during the nozzle tests. All mixtures appeared to be normal emulsions. However, we did not make any tests on the stability of the emulsion without agitation. The long term stability of the emulsion may be affected by the amount of initial agitation, type and concentration of salts in water supply, and time without agitation.

Table I contains a summary of the drop size spectra from the tests with the three tank mixtures. The results follow a trend that would be expected. As shown the volume median diameter of the spray was the smallest (165 μm) for the spray mixture containing the highest concentration of Triton adjuvant while without the adjuvant the volume median diameter was significantly larger (188 μm). The droplet size is, of course, also related to the flow rate/nozzle and airspeed. Thus, we do not have any other test data to directly compare with above results. For reference, one test that is somewhat similar, except for flow rate, was reported in "Drop size spectra of rotary atomizers with *Bacillus thuringiensis* tank mixes," FPM 86-1, Oct. 85, U.S.D.A., Forest Service, Forest Pest Management, Davis, CA. In this report the volume median diameter was 126 μm for a Beecomist at 70 mph, a tank mix of 50% Dipel 8L, and a flow rate of 0.88 gpm/nozzle. Thus, the present result appear to be in line with the previous tests with the difference in volume median diameter attributed to flow rate and tank mixture. Both variables have a pronounced effect on the drop size spectra. The complete tables of drop size data and graphs of the distribution pattern for each test are given in the appendix.

Table I

Summary, drop size spectra of 3 tank mixes from a Beecomist nozzle w/standard screen, 28 VDC, airspeed of 90 mph and 3 gal/min/nozzle.

Tank Mix		Drop size, μm			
No.	Pt. Dipel 6L: Pt. Water + Oz. Triton/100 gal	$D_{V.1}$	$D_{V.5}$	$D_{V.9}$	Relative Span
1	1:2 + 24 oz.	90	165	267	1.07
2	1:2 + 12 oz.	92	168	263	1.02
3	1:2	100	188	278	0.95

Appendix

Tank Mix 1

Nozzle	Beecomist	Slice Rate	2.7MHz
RPM	8900	AVG	20000
Spray Pressure	17.5 psi	DFM	1 cm.
Airspeed	90 mph	BAR	1.5
Flow Rate	3 gpm	Distance to Probe	48 cm.
Tank Mix	Water+Dipel+Triton @ 24 oz/100 gal	Sample Interval	60 sec.
		Number of Samples	1
FILE: C:\PMS\DATA\08188713.000		Number of Sample Rings	7

Number of Tests Combined:1

UPPER LIMIT	N(RAW)	N/SEC	Gm/SEC	% N	% VOL.	ACCUMULATED % N	ACCUMULATED % VOL.
56	4697	2.13E+11	7020.55	54.25	3.22	54.25	3.22
89	5706	6.93E+10	13769.03	17.61	6.31	71.86	9.53
122	3884	4.99E+10	30284.36	12.68	13.89	84.54	23.42
154	3232	3.31E+10	45292.02	8.41	20.77	92.95	44.19
187	2322	1.48E+10	38401.02	3.77	17.61	96.72	61.80
220	1877	7.12E+09	31143.54	1.81	14.28	98.53	76.08
252	1631	3.47E+09	23630.13	0.88	10.84	99.42	86.92
284	1068	1.48E+09	14856.68	0.38	6.81	99.79	93.73
318	570	5.53E+08	7950.73	0.14	3.65	99.93	97.38
351	211	2.05E+08	4004.62	0.05	1.84	99.98	99.22
382	58	4.96E+07	1266.36	0.01	0.58	100.00	99.80
414	14	9.52E+06	313.49	0.00	0.14	100.00	99.94
447	4	3.06E+06	127.32	0.00	0.06	100.00	100.00
TOTAL	2.53E+04	3.93E+11	2.18E+05				

TOTAL ACCEPTED RAW PARTICLES / TOTAL IMAGES = 25274/ 36579 = 69.1%

NUMBER MEAN DIA.= D_{10}.... 73.09 µm
VOLUME MEAN DIA.= D_{30}.... 101.96 µm
SAUTER MEAN DIA.= D_{32}.... 139.69 µm

NUMBER MEDIAN DIA.= $D_{N.1}$... <56 µm
$D_{N.5}$... <56 µm
$D_{N.9}$... 143.02 µm

VOLUME MEDIAN DIA.= $D_{V.1}$... 90.05 µm
$D_{V.5}$... 165.18 µm
$D_{V.9}$... 266.71 µm

RELATIVE SPAN= 1.07

Nozzle Type . . . Beecomist
RPM 8900
Spray Pressure . . 17.5 psi
Airspeed . . . . . 90 mph
Flow Rate 3
Tank Mix: Water+Dipel+Triton
@ 24 oz/100 gal
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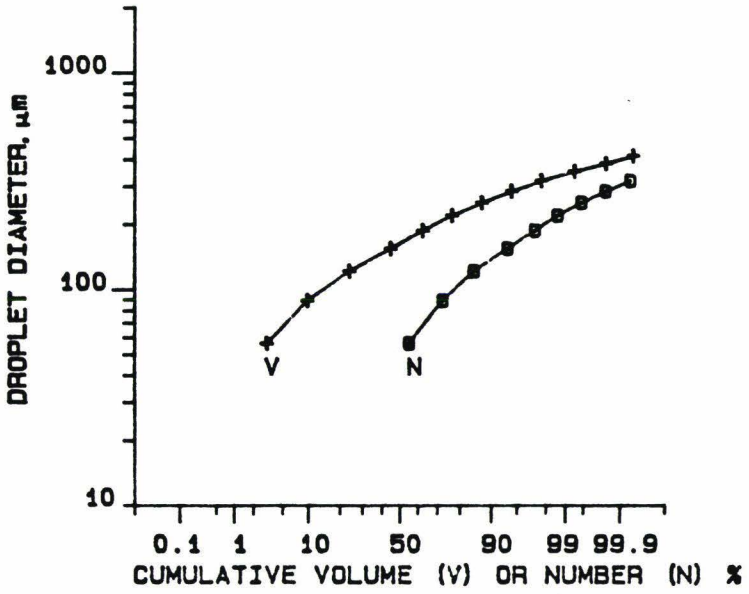

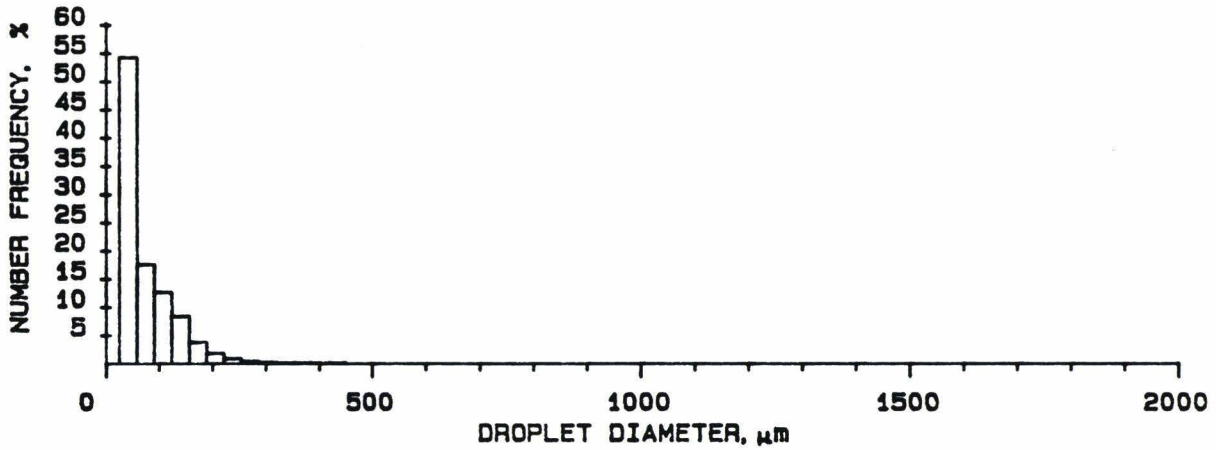

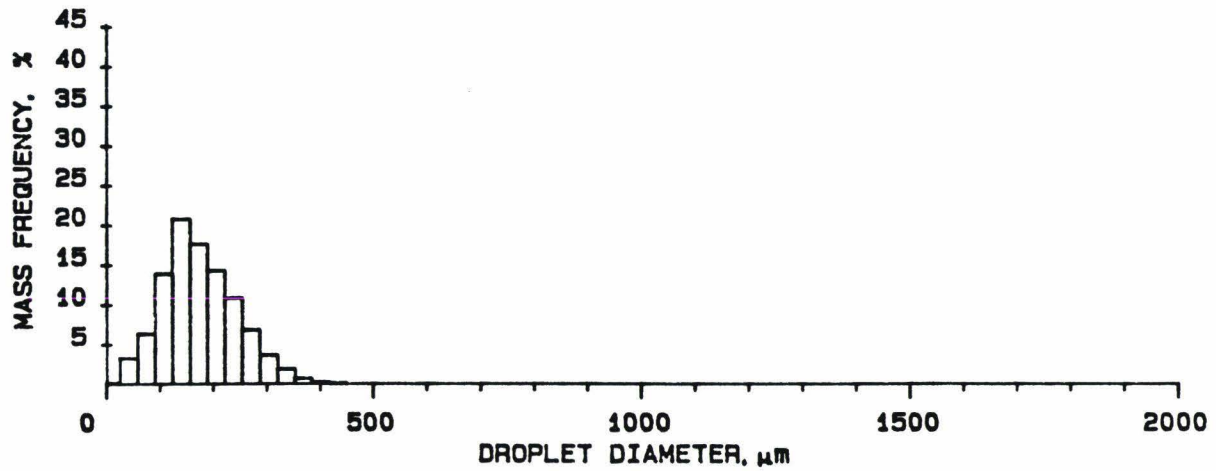

Tank Mix 2

Nozzle	Beecomist	Slice Rate	2.7MHz
Angle to Airstream	0 degrees	AVG	20000
Spray Pressure	18 psi	DFM	1 cm.
Airspeed	90 mph	BAR	1.5
Flow Rate	3 gpm	Distance to Probe	48 cm.
Tank Mix	Water+Dipel+Triton	Sample Interval	60 sec.
	@ 12 oz/100 gal	Number of Samples	1
FILE: C:\PMS\DATA\08188712.000		Number of Sample Rings	7

Number of Tests Combined:1

UPPER LIMIT	N(RAW)	N/SEC	Gm/SEC	% N	% VOL.	ACCUMULATED % N	ACCUMULATED % VOL.
56	5470	2.19E+11	7204.17	55.33	3.15	55.33	3.15
89	5893	6.55E+10	13024.20	16.55	5.70	71.88	8.86
122	3623	4.49E+10	27247.73	11.34	11.93	83.22	20.79
154	3379	3.57E+10	48887.85	9.03	21.41	92.25	42.20
187	2316	1.69E+10	43613.35	4.26	19.10	96.50	61.30
220	1754	7.53E+09	32962.77	1.90	14.44	98.41	75.74
252	1451	3.98E+09	27126.01	1.01	11.88	99.41	87.62
284	878	1.56E+09	15691.00	0.39	6.87	99.81	94.49
318	408	5.41E+08	7781.38	0.14	3.41	99.95	97.90
351	147	1.60E+08	3127.74	0.04	1.37	99.99	99.27
382	47	4.05E+07	1035.20	0.01	0.45	100.00	99.72
414	10	1.05E+07	344.66	0.00	0.15	100.00	99.87
447	3	3.63E+06	151.34	0.00	0.07	100.00	99.94
479	1	2.79E+06	144.39	0.00	0.06	100.00	100.00
TOTAL	2.54E+04	3.96E+11	2.28E+05				

TOTAL ACCEPTED RAW PARTICLES / TOTAL IMAGES = 25380/ 37262 = 68.1%

NUMBER MEAN DIA.= D_{10}.... 73.50 µm
VOLUME MEAN DIA.= D_{30}.... 103.33 µm
SAUTER MEAN DIA.= D_{32}.... 142.12 µm

NUMBER MEDIAN DIA.= $D_{N.1}$... <56 µm
$D_{N.5}$... <56 µm
$D_{N.9}$... 146.39 µm

VOLUME MEDIAN DIA.= $D_{V.1}$... 92.10 µm
$D_{V.5}$... 167.77 µm
$D_{V.9}$... 263.24 µm

RELATIVE SPAN= 1.02

Tank Mix 2

Nozzle Type . . . Beecomist
Angle to Airstream 0°
Spray Pressure . . 18 psi
Airspeed . . . . . 90 mph
Flow Rate 3
Tank Mix: Water+Dipel+Triton
@ 12 oz/100 gal
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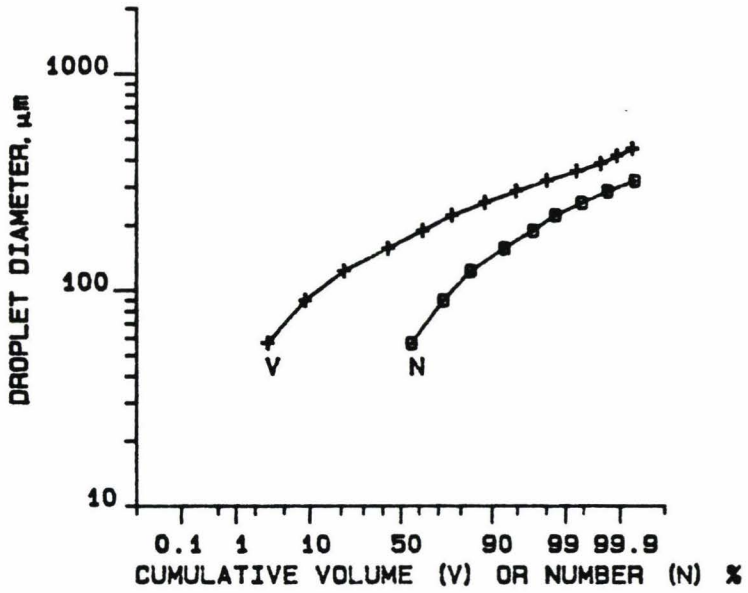

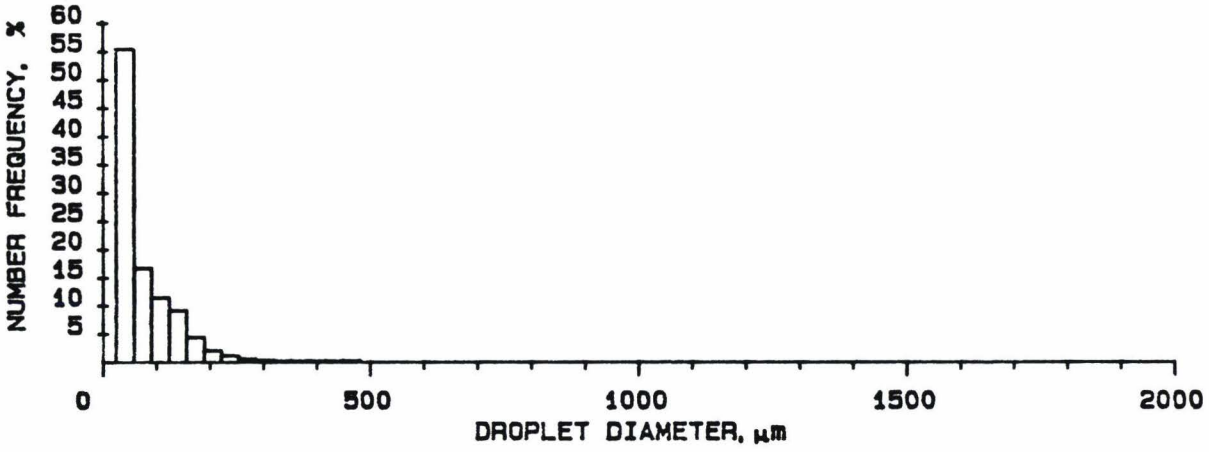

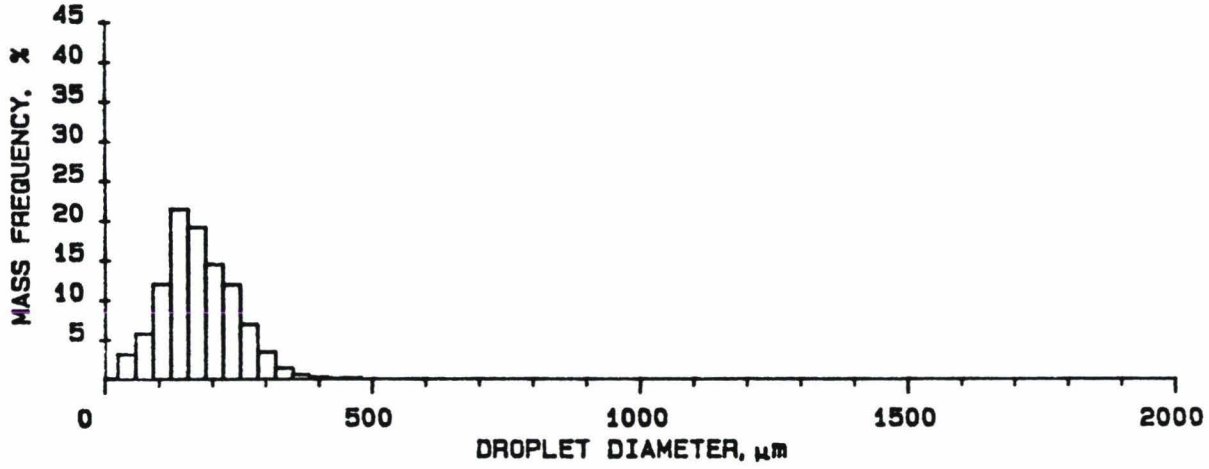

Tank Mix 3

Nozzle	Beecomist	Slice Rate	2.7MHz
RPM	8700	AVG	20000
Spray Pressure	18 psi	DFM	1 cm.
Airspeed	90 mph	BAR	1.5
Flow Rate	3 gpm	Distance to Probe	48 cm.
Tank Mix	Water + Dipel @ 2:1	Sample Interval	60 sec.
		Number of Samples	1
FILE: C:\PMS\DATA\08178717.000		Number of Sample Rings	7

Number of Tests Combined:1

UPPER LIMIT	N(RAW)	N/SEC	Gm/SEC	% N	% VOL.	ACCUMULATED % N	ACCUMULATED % VOL.
56	4993	1.55E+11	5091.57	49.61	2.10	49.61	2.10
89	6401	5.37E+10	10681.82	17.22	4.40	66.83	6.50
122	3864	4.03E+10	24462.04	12.91	10.08	79.75	16.59
154	3109	2.93E+10	40049.77	9.38	16.51	89.13	33.10
187	2627	1.54E+10	39922.71	4.95	16.46	94.07	49.56
220	2421	9.36E+09	40960.02	3.00	16.89	97.07	66.44
252	1983	5.52E+09	37577.61	1.77	15.49	98.84	81.93
284	1417	2.46E+09	24735.40	0.79	10.20	99.63	92.13
318	759	8.27E+08	11891.17	0.27	4.90	99.89	97.03
351	295	2.37E+08	4637.30	0.08	1.91	99.97	98.95
382	104	7.06E+07	1804.13	0.02	0.74	99.99	99.69
414	25	2.10E+07	691.27	0.01	0.28	100.00	99.97
447	4	1.51E+06	62.97	0.00	0.03	100.00	100.00
TOTAL	2.80E+04	3.12E+11	2.43E+05				

TOTAL ACCEPTED RAW PARTICLES / TOTAL IMAGES = 28002/ 39964 = 70.1%

NUMBER MEAN DIA.= D_{10}.... 80.66 µm
VOLUME MEAN DIA.= D_{30}.... 114.13 µm
SAUTER MEAN DIA.= D_{32}.... 156.79 µm

NUMBER MEDIAN DIA.= $D_{N.1}$... <56 µm
$D_{N.5}$... 57.02 µm
$D_{N.9}$... 160.13 µm

VOLUME MEDIAN DIA.= $D_{V.1}$... 100.38 µm
$D_{V.5}$... 187.77 µm
$D_{V.9}$... 277.90 µm

RELATIVE SPAN= 0.95

Nozzle Type . . . Beecomist
RPM 8700
Spray Pressure . . 18 psi
Airspeed . . . . . 90 mph
Flow Rate 3
Tank Mix: Water + Dipel @ 2: 1

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